Page Content

Overview for stormwater ponds

This section provides an overview of stormwater **wet ponds** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_ponds). It includes a discussion of permit applicability, function within the treatment train, cold climate and retrofit suitability, and role in water quality and quantity treatment.

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Contents

Function within stormwater treatment train

Stormwater ponds are typically installed as an end-of-pipe BMP at the downstream end of the **treatment train** (https://stormwater.pca.state.mn.us/index.php?title=Using_the_treatment_train_approach_to_BMP_selection). Stormwater pond size and outflow regulation requirements can be significantly reduced with the use of additional upstream BMPs. However, due to their size and versatility, stormwater ponds are often the only management

practice employed at a site and therefore must be designed to provide adequate water quality and water quantity treatment for all regulated storms.


Photo of a wet pond.

MPCA permit applicability

One of the goals of this manual is to facilitate understanding of and compliance with the MPCA Construction General Permit (https://stormwater.pca.state.mn.us/index.php?title=Construction_stormwater_program)(CGP), which includes design and performance standards for permanent stormwater management systems. These standards must be applied in all projects in which at least one acre of new impervious area (or common area of development) is being created, and the permit stipulates certain standards for various categories of stormwater management practices.

For regulatory purposes, stormwater ponds fall under the category *Wet Sedimentation Basin* described in the CGP. If used in combination with other practices, **credit (stormwater credit)** (https://stormwater.pca.state.mn.us/index.php?title=Overview_of_stormwater_credits) for combined stormwater treatment can be given. Due to the statewide prevalence of the MPCA CGP, design guidance in this section is presented with the assumption that the permit does apply. Also, although it is expected that in many cases the pond will be used in combination with other practices, standards are described for the case in which it is a stand-alone practice.

Of course, there are situations, particularly retrofit projects, in which a stormwater pond is constructed without being subject to the conditions of the MPCA CGP. While compliance with the permit is not required in these cases, the standards it establishes can provide valuable design guidance to the user. It is also important to note that additional and potentially more stringent design requirements may apply for a particular pond, depending on where it is situated both jurisdictionally and within the surrounding landscape.

Retrofit suitability

Ponds are widely used for stormwater retrofits and have two primary applications as a retrofit design. In communities where dry detention ponds (see Types of stormwater ponds) were designed for flood control in the past, these facilities can be modified by adding a **permanent pool** for water quality treatment and adapting the outlet structure for channel protection. This is desirable because dry ponds have limited effectiveness for pollutant removal. Alternatively, new ponds can be installed in available open areas as a part of a comprehensive watershed retrofit inventory.

Note that the MPCA CGP permanent pool specifications do not apply to retrofit ponds that serve an existing developed area unless new impervious acreage occurs as part of the retrofit project. Therefore, any of the aforementioned pond variants may be considered, along with other alternative approaches to treatment basin design.

Special receiving waters suitability

The table below provides guidance regarding the use of stormwater ponds in areas upstream of special **special receiving waters** (https://stormwater.pca.state.mn.us/index.php?title=Special_Waters_and_Impaired_Waters).

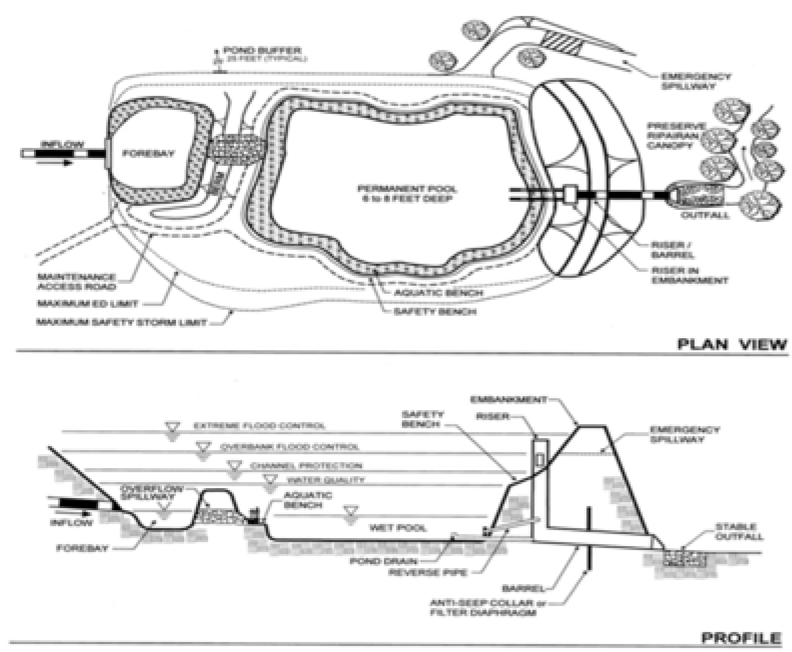
Design restrictions for special waters - constructed ponds and wetlands
Link to this table

BMP	Watershed Management Category				
	A **Lakes**	**B** **Trout Waters**	**C** **Drinking Water***	**D** **Wetlands**	**E** **Impaired Waters**
Constructed wetlands	Some variations NOT RECOMMENDED due to poor P removal, combined with other treatments.	NOT RECOMMENDED except for wooded wetlands	RECOMMENDED	RECOMMENDED but no use of natural wetlands	RECOMMENDED
Wet Extended Detention Pond	RECOMMENDED	Some variations NOT RECOMMENDED due to pool and stream warming concerns	RECOMMENDED	RECOMMENDED (alteration of natural wetlands as stormwater wetlands not allowed)	RECOMMENDED

*Applies to groundwater drinking source areas only; use the sensitive lakes category to define BMP Design restrictions for surface water drinking supplies

Cold climate suitability

One of the biggest problems associated with proper pond operation during cold weather is the freezing and clogging of inlet and outlet pipes. To avoid these problems, the Center for Watershed Protection (http://www.cwp.org/) (Caraco and Claytor, 1997 (https://stormwater.pca.state.mn.us/index.php?title=References_for_stormwater_ponds)) made some general design suggestions, which are adapted as follows.



Plan and profile view of a wet detention pond. Click on image to enlarge.

- Inlet pipes should not be submerged, since this can result in freezing and upstream damage or flooding.
- Burying all pipes below the frost line can prevent frost heave and pipe freezing. Wind protection can also be an important consideration for pipes above the frost line. In these cases, designs modifications that have pipes “turn the corner” are helpful.
- Incorporating winter operating levels as part of the design to introduce available storage for melt events (see figure at right and Cold climate impact on runoff management).
- Increase the slope of inlet pipes to a minimum of 1 percent to prevent standing water in the pipe, reducing the potential for ice formation. This design may be difficult to achieve at sites with flat local slopes.

- If perforated riser pipes are used, the minimum opening diameter should be ½ inch. In addition, the pipe should have a minimum 8 inch diameter.
- When a standard weir is used, the minimum slot width should be 3 inches, especially when the slot is tall.
- Baffle weirs can prevent ice reformation during the spring melt near the outlet by preventing surface ice from blocking the outlet structure.
- In cold climates, riser hoods should be oversized and reverse slope pipes should draw from at least 6 inches below the typical ice layer.
- Alternative outlet designs that have been successful include using a pipe encased in a gravel jacket set at the elevation of the aquatic bench as the control for water-quality events. This practice both avoids stream warming and serves as a non-freezing outlet.
- Trash racks should be installed at a shallow angle to prevent ice formation.

Water quantity treatment

Ponds are one of the best and most cost-effective stormwater treatment practices for providing runoff detention storage for channel protection and overbank flood control (see Unified sizing criteria). These goals are achieved with the use of extended detention storage, where runoff is stored above the permanent pool and released at a specified rate through a control structure. Wherever an embankment is constructed to store water at a level higher than the surrounding landscape, dam safety regulations must be followed to ensure that downstream property and structures are adequately protected.

Ponds are primarily detention practices and therefore do not retain significant amounts of water. There is some loss to **evapotranspiration** and seepage through the bottom of the pond.

Water quality

Information: The discussion of water quality credits applies only to wet ponds. Dry ponds do not receive credit for volume or pollutant removal

Ponds rely on physical, biological, and chemical processes to remove pollutants from incoming stormwater runoff. The primary treatment mechanism is gravitational settling of particulates and their associated pollutants as stormwater runoff resides in the pond. Another mechanism for the removal of pollutants (particularly nutrients) is uptake by algae and aquatic vegetation. **Volatilization** and chemical activity can also occur, breaking down and assimilating a number of other stormwater contaminants such as **hydrocarbons**.

The longer the runoff remains in the pond, the more settling (and associated pollutant removal) and other treatment can occur, and after the particulates reach the bottom of the pond, the permanent pool protects them from resuspension when additional runoff enters the basin. For these reasons, because they lack the crucial permanent pool, dry extended detention ponds are not considered an acceptable option for meeting water quality treatment goals; however, they may be appropriate to meet water quantity criteria (V_{cp}, V_{p10}, V_{p100}; see Unified sizing criteria). It should again be noted that the only type of pond complying with the MPCA CGP is the wet extended detention pond (or wet sedimentation basin) constructed according to the minimum standards outlined in the permit.

The long detention or retention time associated with stormwater ponds can be problematic in coldwater fisheries due to the potential increase in water temperature. In these situations, detention times should be limited to a maximum of 12 hours or other treatment alternatives (**infiltration** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_infiltration_Best_Management_Practices)) should be explored.

Removal efficiencies and typical stormwater pond effluent concentrations for key pollutants for wet extended detention ponds are provided in the following two tables.

Median pollutant removal percentages for several stormwater BMPs. Sources (http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs#References). More detailed information and ranges of values can be found in other locations in this manual, as indicated in the table.
Link to this table

Practice	TSS	TP	PP	DP	TN	Metals[1]	Bacteria	Hydrocarbons
Infiltration (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_infiltration_Best_Management_Practices)[2]	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]
Biofiltration and Tree trench/tree box with underdrain	80	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	50	35	95	80
Sand filter	85	50	85	0	35	50	80	80
Iron enhanced sand filter (http://stormwater.pca.state.mn.us/index.php/Iron_enhanced_sand_filter_%28Minnesota_Filter%29)	85	74	85	60[6]	35	50	80	80
Dry swale	68	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	link to table (http://stormwater.pca.state.mn.us/index.php/Phosphorus_credits_for_bioretention_systems_with_an_underdrain)	35	0	80	80
Wet swale	35	0	0	0			0	
Constructed wet ponds[4, 5]	84	46	84	0	30	70	60	80

Practice	TSS	TP	PP	DP	TN	Metals[1]	Bacteria	Hydrocarbons
Constructed wetlands	73	38	69	0	30	70	60	80
Permeable pavement	74	41	82	0				
Green roofs	85	0	0	0				

TSS=Total suspended solids, TP=Total phosphorus, PP=Particulate phosphorus, DP=Dissolved phosphorus, TN=Total nitrogen

[1]Data for metals is based on the average of data for zinc and copper

[2]BMPs designed to infiltrate stormwater runoff, such as infiltration basin/trench, bioinfiltration, permeable pavement with no underdrain, tree trenches with no underdrain, and BMPs with raised underdrains.

[3]Pollutant removal is 100 percent for the volume infiltrated, 0 for water bypassing the BMP. For filtered water, see values for other BMPs in the table.

[4]Dry ponds do not receive credit for volume or pollutant removal

[5]Removal is for Design Level 2 (https://stormwater.pca.state.mn.us/index.php?title=Requirements,_recommendations_and_information_for_using_stormwater_pond_as_a_BMP_in_the_MIDS_calculator#Pollutant_Reduction)

[6]Removal is for Tier 2 iron enhanced sand filter. Tier 1 removal is 40 percent, resulting in a TP removal of 65%

Typical pollutant concentrations leaving stormwater pond BMPs. Concentrations are in milligrams per liter (ppm). Note that a range of values, from low to high, is provided for TSS and TP
Link to this table

Practice	TSS Low-Med-High	TP Low-Med-High	TN	Cu	Zn
Stormwater Ponds	10-19-30	0.10-0.17-0.25	1.3	0.005	0.030

Limitations

The following general limitations should be recognized when considering installation of stormwater ponds. Ponds generally

- consume a large amount of space,
- tend to increase water temperature and may cause downstream thermal impact,
- have the potential for nuisance insects or odor,
- are problematic for areas of low relief, high water table, or near-surface bedrock, and
- pose safety concerns

Related pages

- Overview for stormwater ponds
- Types of stormwater ponds
- Design criteria for stormwater ponds
- Design considerations for constructed stormwater ponds used for harvest and irrigation use/reuse
- Construction specifications for stormwater ponds
- Assessing the performance of stormwater ponds

- Operation and maintenance of stormwater ponds
- Cost-benefit considerations for stormwater ponds
- Calculating credits for stormwater ponds
- Stormwater wet pond fact sheet
- References for stormwater ponds
- Requirements, recommendations and information for using stormwater pond as a BMP in the MIDS calculator